

## Reevaluation and New Description of the Genus *Bittium* (Cerithiidae)

BY

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(1 Plate)

### INTRODUCTION

THE GENUS *Bittium* Gray, 1847 was proposed in manuscript form by Leach for a classification of British mollusca and was subsequently published by GRAY (1847a). Leach's list referred *Bittium* and many other diverse genera to the Purpuridae and under the 65<sup>th</sup> entry, listed *Bittium reticulatum*, *Murex tuberculare*, *M. adversum*, *M. elegantissimum*, and *M. spenceri*, consecutively. Besides *Bittium reticulatum*, the other species listed by Leach comprise 2 genera, *Triphora* Blainville, 1828 and *Cerithiopsis* Forbes & Hanley, 1853. No description of the genus was given nor was a type-species designated. Three months later, GRAY (1847b: 154) cited only *Bittium reticulatum* (Costa, 1778), which becomes the type-species by subsequent designation (Figure 1).

To my knowledge, the earliest diagnosis of the genus is that written by H. & A. ADAMS (1854): "Operculigerous lobe with rudimentary expansions on each side and furnished with a roundish, lanceolate cirrus (Lovén). Operculum subcircular, of four volutions. Shell turreted, many-whorled, granular, often with irregular varices; aperture with a slight canal in front, not produced or recurved; inner lip simple; outer lip acute, not reflexed or expanded." Note that this definition mentions the presence of an anterior canal, a point to which I shall return later. Subsequent classic monographic treatments of the Cerithiidae failed to elaborate on the genus and did not specify further characters.

### HISTORICAL REVIEW AND STATUS OF GENUS *Bittium*

There appears to have been some confusion among early workers about the exact placement and rank of *Bittium*. SOWERBY (1855) included *Bittium* in the introductory title of his monograph of *Cerithium* but did not cite it elsewhere in the text; moreover, he referred *Bittium reticulatum* to his "Cerithiopsis group." REEVE (1865) did not even mention the name *Bittium*. TRYON (1887) gave it generic recognition but offered no diagnosis. CHENU (1859) appears to have copied the definition of H. & A. ADAMS (1854) but included *Bittium* in the family Potamididae where it was assigned as a subgenus of *Potamides* (sic) [= *Potamides* Brongniart, 1810], JEFFREYS (1867) lumped *Bittium* under *Cerithium*. DALL (1892) later wrote a diagnosis of the genus *Bittium* that was obviously formulated from his knowledge of Recent and fossil North American species. He mentioned that the last whorl is usually contracted and overhung by its predecessor. This is typical in some individuals of American species, but there is a great deal of variation within specific populations. DALL (*op. cit.*) also noted the close resemblance of *Bittium* to the genera *Diastoma* Deshayes, 1850, *Sandbergeria* Bosquet, 1861, *Alaba* Adams & Adams, 1853, and *Styliferina* A. Adams, 1860 [= *Diala* A. Adams, 1861] and added that the limits of these genera seemed to be quite artificial.

An obvious feature of *Bittium reticulatum*, type-species of *Bittium*, is the presence of a short, shallow, but distinct

anterior canal. This was mentioned by H. & A. ADAMS (1854) in their description of the genus. The presence of an anterior canal is noted in most subsequent treatments of *Bittium* (CHENU, 1859; TRYON, 1887; BUCQUOY, DAUTZENBERG & DOLFUS, 1884; FISCHER, 1877; DALL, 1892; COSSMANN, 1906). Most modern authors also refer to a short anterior canal in their definitions of *Bittium* (WOODRING, 1928; OLSSON & HARBISON, 1953; MCLEAN, 1969; ABBOTT, 1974) although KEEN (1971) regarded it as "a slight anterior notch, not a canal."

*Bittium* species are frequently referred to other genera. Keen included *Bittium* in the subfamily Cerithiopsinae but the radulae, larvae and anatomy of *Cerithiopsis* species are far-removed from those of *Bittium* and they should not be considered a closely related group (see FRETTER, 1951; FRETTER & PILKINGTON, 1970; JOHANSSON, 1956). Recently, ABBOTT (1974) referred several American species of *Bittium* to the genus *Diastoma* Deshayes, 1850. His placement of these species was followed by EMERSON & JACOBSON (1976). DALL (1889) was the first worker to confuse American members of the genus *Bittium* with *Diastoma* Deshayes, 1850 when he referred the common eastern species, *Bittium varium* Pfeiffer, 1840, to *Diastoma*. DALL (1889) noted that DESHAYES (1850) considered *Diastoma* to be a rissoid but the former regarded *Diastoma* as a subgroup of *Bittium* and added that *Alaba* Adams & Adams, 1853 was also very similar to *Bittium*. Although *Diastoma* was placed in the Cerithiidae by FISCHER (1884) and COSSMANN (1889), it is now regarded as a separate family, Diastomatidae (see LUDBROOK, 1971). The genus *Diastoma* embraces a group of relatively large snails and is best known from the Eocene of the Paris Basin. DESHAYES (1850) designated *Melania costellata* Lamarck, 1804 as the type-species and later (1864, Description des Animaux san Vertèbres, 2: 413-414) described it in detail. This species is large (about 40 mm in length) and the lower portion of the outer lip is a smooth semicircle with no evidence of an anterior canal or even a shallow flared depression. Excellent illustrations of this type-species, cited as *Melania costellata* Lamarck, appear in FAVRE (1918: plt. 2, figs. 26-30). LUDBROOK (1971) has discussed the nomenclatural problems of *Diastoma* in more detail and has pointed out that small cerithiids such as those described from Southern California as *Diastoma fastigiata* (Carpenter, 1864), *D. oldroydae* Bartsch, 1911, and *D. stearnsi* Bartsch, 1911, and an east coast species, *D. virginica* Henderson & Bartsch, 1914 [= *Bittium varium* Pfeiffer] differ from

true *Diastoma* by their small size, different sculpture and in the possession of a short, shallow anterior canal. The only living species of *Diastoma*, *D. melanoides* (Reeve, 1849) is found in a very restricted area in south-western Australia and off Eyre Peninsula in South Australia (LUDBROOK, 1971). This moderately sized species was figured by REEVE (1849, 5: plt. 1, fig. 3) under his section on *Mesalia* Gray, 1840 and is very unlike the small *Bittium* species of authors. I have been unable to examine a specimen of *Diastoma melanoides* but COTTON (1932) stated that it bears close relationship to fossil species of *Diastoma* even though the upper portion of the outer lip is not as far detached from the body whorl as is the lip in *D. costellata*. It is thus clear that the referral of American species of *Bittium* to *Diastoma* by DALL (1889), BARTSCH (1911), KEEN (1971), ABBOTT (1974) and EMERSON & JACOBSON (1976) should be considered erroneous.

The subgenus *Bittinella* Dall, 1924 was proposed to accommodate *Bittium hiloense* Pilsbry & Vanatta, 1908, from Hawaii. I suggest that this species and *Cerithium zebrum* Kiener, 1841, referred to *Bittium* by CERNOHORSKY (1972), are merely very small members of the genus *Cerithium* Bruguière. Both species have thick, heavy shells, short, deep anterior canals and thick, crenulated outer lips that are different from most other species of *Bittium*.

GRANT & GALE (1931: 731) suggested that many subdivisions of *Bittium* were probably artificial and should be discarded as soon as a natural classification was worked out. My studies on living populations of cerithiids and familiarity with numerous fossil groups and species have convinced me that the adaptive radiation of this large group has led to frequent convergence in shell form, sculpture and radular morphology. Most of the supraspecific taxa proposed for *Bittium* are parochial in conception and scope, are based on specific rather than generic characters and convey misleading or little phylogenetic information. In the interest of pragmatism and taxonomic parsimony I am suggesting that a number of generic and subgeneric taxa be abandoned or synonymized. All species formerly referred to these taxa should be considered as *Bittium* species until the entire group is monographed and subgeneric taxa can be properly evaluated on the basis of more than shell characters.

In order to promote taxonomic stability and to clarify the problems discussed above I herein present a synonymy and redescription of the genus *Bittium*.

## SYNONYMY

*Cerithiinae* Fleming, 1828

*Bittium* Leach in Gray, 1847

*Bittium* 1847 (Oct.), LEACH in GRAY, Ann. Mag. Nat. Hist., 20: 270. Type-species, *Murex reticulatus* (Montagu, 1803) (= *Strombiformis reticulatus* Costa, 1778), by SD Gray, 1847 (Nov.), Proc. Zool. Soc. London part 15 (178): 154

*Cerithiolum* 1869, TIBERI, Boll. Malacol. Ital. 2: 263. Type-species, *Cerithiolum (Strombiformis) reticulatum* (Da Costa, 1778), by OD

*Semibittium* 1869, COSSMANN, Ann. Soc. malac. Belg., Mem. 31: 29. Type-species, *Cerithium cancellatum* Lamarck, 1804, by OD

*Bittiolium* 1906, COSSMANN, Essais Paléoconch. 7: 139. Type-species *Bittium podagrinum* Dall, 1892, by OD

*Stylium* 1907, DALL in BARTSCH, Proc. U. S. Nat. Mus. 33 (1564): 178. Type-species, *Bittium (Stylium) eschrichtii* (Middendorff, 1849), by OD

*Lirobittium* 1911, BARTSCH, Proc. U. S. Nat. Mus. 40 (1826): 384-385. Type-species, *Bittium (Lirobittium) catalinensis* Bartsch, 1907, by OD

*Monobittium* 1917, MONTEROSATO, Boll. Soc. Zool. Ital. (3) 4: 20. Type-species, *Monobittium latreillei* (Payraudeau, 1826), by M

*Inobittium* 1917, MONTEROSATO, Boll. Soc. Zool. Ital. (3) 4: 20. Type-species, *Inobittium lacteum* (Philippi, 1836) by M

*Zebittium* 1927, FINLAY, Trans. New Zeal Inst. 57: 381. Type-species *Zebittium exile* (Hutton, 1873), by OD

*Cacozeliana* 1928, STRAND, Arch. Naturgesch. Berlin, 92: 66. nom. nov. per *Cacozelia* Iredale, 1924, Proc. Linn. Soc. N. S. W. 49: 246 [non GROTE, 1878]. Type-species, *Cerithium lacertina* Gould, 1861, by OD

*Bittiscalia* 1937, FINLAY & MARWICK, Paleo. Bull. New Zeal. 15: 44. Type-species, *Bittiscalia simplex* (Marshall, 1917), by OD

*Eubittium* 1937, COTTON, S. Austral. Natural. 18: 2 [= *Paracerithium* Cotton, 1932 (non COSSMANN, 1902)]. Type-species, *Eubittium lawleyanum* (Crosse, 1863), by OD

*Brachybittium* 1962, WEISBORD, Bull. Amer. Paleont. 17 (193): 175-176. Type-species, *Bittium (Brachybittium) carabobense*, Weisbord, 1962, by OD

*Dahlakia* 1971, BIGGS, Journ. Conchol. 27: 221. Type-species, *Dahlakia leilae* Biggs, 1971 (= *Cerithium proteum* Jousseaume, 1930), by OD

## DESCRIPTION

## Shell

Shell small, turreted and elongate, consisting of many moderately inflated or angular whorls (6-10). Sculpture

normally reticulate, of varying combinations of spiral cords and axial riblets, frequently beaded at intersections. Usually 3 spiral cords per whorl. Former varices usually present at irregular intervals. Suture distinct, straight. Protoconch about 2½ whorls, smooth, but sometimes with several spiral lirations. Frequently, teleoconch strongly reticulate. Aperture ovate with short, shallow, anterior siphonal canal that is not reflected backwards. Weak anal sinus present. Columella concave and with slight callus. Outer lip thin, smooth and rounded, occasionally flared at the base on some individuals. Base of last whorl sculptured with 5-6 spiral cords. Last whorl occasionally contracted in some individuals. Periostracum thin.

## Animal

Moderate sized foot with ciliated duct on right side terminating in knob-like ovipositor. Operculum thin, corneous, ovate and paucispiral with an excentric nucleus. Snout moderately large, flattened dorso-ventrally. Eyes at bases of tentacles. Mantle cavity deep with long monopectinate ctenidium extending its length, ending at anterior siphon. Osphradium bipectinate. Hypobranchial gland well-developed, large. Intestine wide, rectum distal to end of gonoduct. Feces cylindrical with mucus filament at one end. Pallial gonoducts in both sexes open, consisting of 2 laminae joined dorsally to mantle roof. Males aphallic, producing spermatophores about 1 mm in length containing eupyrene and apyrene spermatozoa. Eupyrene spermatozoa with nucleus about one-twentieth the total length of sperm and with spiral keel on flagellum. Female pallial oviduct a glandular groove between 2 deep laminae joined at dorsal wall and open ventrally. In medial lamina, an open sperm-collecting gutter runs into a ciliated tube that opens into a "bursa" at the proximal end of the medial lamina. Bursa is anterior to 2 seminal receptacles, the 1<sup>st</sup> of which serves as a receptacle for the spermatophore, in the left wall of the duct and the 2<sup>nd</sup> along the free edge of the wall. Nervous system characterized by very large nerve ring and large cerebral ganglia. Jaws cuticular, conical and rough surfaced. Stomach with style-sac and large crystalline style.

## Radula

Radula taenioglossate, ribbon long, about 50 rows. Rachidian tooth squarish, concave at top with one large central cusp flanked by 3 denticles on each side. Base of rachidian concave with 2 short lateral projections. Lateral tooth rhomboidal, serrated on top with 2 small entocones, large pointed mesocone and 4 small ectocones, respectively. Base of lateral tooth with 2 extensions, 1 at each side; outer basal projection broad, long and extending

laterally. Marginal teeth long, curved, spatulate and serrated at tips. Inner marginal tooth serrated with 4 entocones, large pointed mesocone and 3 sharp ectocones. Outer marginal tooth serrated with 4 to 6 entocones, outer surface smooth.

### Eggs and Larvae

Eggs tiny, deposited in gelatinous string that may be coiled counterclockwise into a spiral from 3 to 25 mm in length or irregularly folded on itself. Egg mass containing several hundred small, opaque eggs, each about 60-70  $\mu\text{m}$  in diameter. Larvae planktotrophic with bilobed, colorless velum; right velar lobe somewhat larger than left. Larval foot colorless. Larval shell about 2½ whorls, smooth except for median spiral ridge on 2<sup>nd</sup> whorl. Sutures and columella reddish brown. Outer lip with prominent tongue-shaped beak.

### REMARKS

The description given above is based upon *Bittium reticulatum*, *B. varium*, and several other *Bittium* species from throughout the geographic range of the genus. I have attempted to describe the genus as a whole and not just the type-species. I have also endeavored to formulate a holomorphic description, using characters drawn from all phases of development.

A thorough treatment of the anatomy of *Bittium reticulatum* may be found in JOHANSSON (1947; 1948; 1953). MARCUS & MARCUS (1963) wrote an extensive paper on the anatomy of *Bittium varium* in which they also described and figured gametes, egg mass and larvae. The spermatozoa of *B. reticulatum* have been figured by FRANZEN (1955: 411; figs. 31-32) and FRETTER & GRAHAM (1962: 339; fig. 176, 4). MARCUS & MARCUS (1963) indicated that the sperm of *B. varium* are very similar to those of *B. reticulatum*. For further information on the anatomy of *Bittium* and illustrations of internal anatomy see FRETTER & GRAHAM (*op. cit.*). Excellent illustrations and treatments of *Bittium* eggs and larvae may be found in THORSON (1946), LEBOUR (1937), FRETTER & PILKINGTON (1970) and RICHTER & THORSON (1975). The last paper contains good scanning electron micrographs of the larval shell of *Bittium* species and a photograph of a living veliger larva.

The reproductive anatomy of *Bittium reticulatum* and *B. varium*, allopatric species that differ in shell size, shape and sculpture, shows that the structures of these conservative tracts are virtually identical between the 2 species and indicates that they are indeed members of the same

genus. There is not a shred of anatomical evidence to support the need of a separate genus to accommodate *Bittium varium* nor is its referral to *Diastoma* justified. Although there is no information about the anatomy of Indo-Pacific and Eastern Pacific species of *Bittium*, it is not unlikely that they are all similar in their anatomy and habits. A small species from the Red Sea that was previously placed in the Potamididae and for which a new genus was created, *Dahlakia* Biggs, 1971, has been found to be a true cerithiid and is now assigned to *Bittium* (HOUBRICK, 1977b, *in press*). The family Cerithiidae is an old, slowly evolving group of prosobranchs (G. M. Davis, pers. comm.) that has not changed significantly since the Tertiary. Although some groups are now extinct, many living species of cerithiids have records going back to the Eocene (see HOUBRICK, 1977). COSSMANN (1906: 137) has recorded *Bittium* as far back as the Paleocene. Fossil *Bittium* species are conchologically very similar to Recent members.

*Bittium* is a genus in the family Cerithiidae and is probably very close in affinity to *Cerithium* Bruguière, 1789. Familial or subfamilial status for the *Bittium* group is not warranted because there are no characters, beyond those of size and a shorter canal, to justify such a great taxonomic difference. Examination of living populations of *Bittium* in Florida, Belize, and Enewetak Atoll and anatomical studies reveal only minor differences between these animals and those of the genus *Cerithium* Bruguière. Cerithiids are highly responsive to microhabitat in their shell shape and sculpture, and even anterior canals may be longer or shorter, depending upon the habitat. Inflation of whorls and spire length are highly correlated with different substrates such as sand, algae, rubble or rock. Populations of a given species frequently exhibit striking ecoclines. Shells of *Bittium* species are remarkably polymorphic in shape and sculpture, and subgenera such as *Lirobittium* Bartsch, 1911, *Styliodium* Dall, 1907, and *Semibittium* Cossmann, 1869 have no taxonomic value because the characters separating them (see BARTSCH, 1911: 384) may be found within a single population of one species and are thus not even good criteria for specific determination. *Bittium* is a genus with a cosmopolitan distribution of species and much of the confusion regarding generic and subgeneric placement of many species has resulted from parochial views of the genus. *Bittium* species have a cosmopolitan distribution and supraspecific taxa proposed solely for regional forms while ignoring other geographic areas and the full range of morphologies in the group are of little value (see Figures 1 to 5).

In conclusion, subgeneric and generic taxa proposed for *Bittium* are based solely upon shell form and sculpture

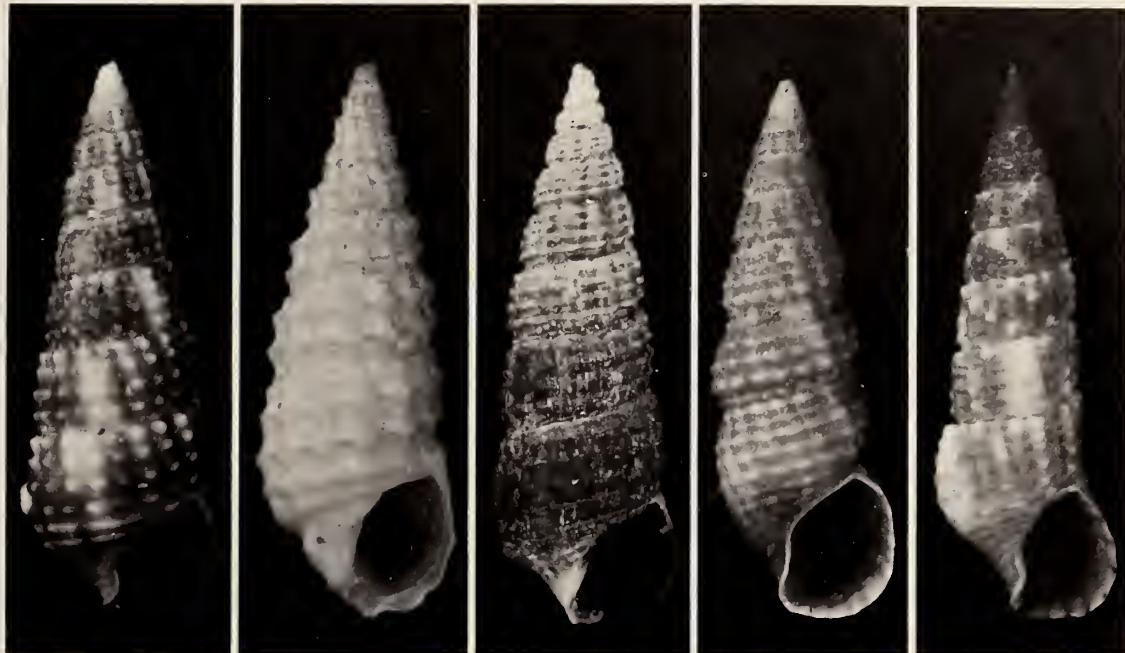


Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

*Bittium* species showing variation in shell form and sculpture as found throughout the genus

Figure 1: *Bittium reticulatum* (Costa, 1778), type-species of the genus, from Cartagena, Spain (12×4 mm)

Figure 2: *Bittium interfossa* (Carpenter, 1864) from Catalina Island, California (7.4×2.5 mm)

Figure 3: *Bittium quadrifilatum* (Carpenter, 1864) from Mission Bay, California (10×5.2 mm)

Figure 4: *Bittium varium* (Pfeiffer, 1840) from Sarasota, Florida (5.8×1.9 mm)

Figure 5: *Bittium varium* (Pfeiffer, 1840) from Chincoteague, Virginia, formerly known as *B. virginicum*, Henderson & Bartsch, 1914 (9.9×2.9 mm)

